

CHAPTER 17

Solutions

Exercise 1

1. Cap/floor volatility is thought to be higher than swaption volatility because, the market buys volatility through swaptions and sells volatility through cap/floors. Everything else being the same the bid-ask difference should make cap/floor volatility a little higher.
 - (a) A callable bond has a higher coupon because the bond incorporates a short swaption. If rates fall below a level, the issuer has the right to call the bond at par. From bondholder's point of view this is equivalent to selling a swaption. The option holder has the right to get into a fixed receiver swap that pays the same coupon at the call date. This embedded option will have a premium and this premium will make the coupon of the callable bond higher. Investors may consider these higher coupons as yield enhancement and buy these bonds. (Callable bonds are usually not callable for a certain period after the issue date. During this period the investor will receive the high coupon regardless of the interest rate movements.)
 - (b) On the other hand caps/floors are used by corporates to hedge the interest rate risk. So, the market will structurally be short caps/floors but long swaptions.
2. Market sells financial services to corporates. One of these services is helping them hedge interest rate risk. This is done using caps and floors. On the other hand, market sells yield enhancement products to investors. These structures are often callable, which results in the embedded swaption.

3. This statement is an example of hedging and risk managing of volatility risk. The industry is buying and selling volatilities and meeting different needs of its clients. However, the two risks are not identical and the “volatility books” need to be carefully managed in order to be properly hedged. Also, note that from the point of view of a volatility trader the same risk can be hedged in (many) different ways and by using different financial instruments. Some alternatives can be cheaper than others.

Exercise 2

- (a) The position of an agency which sells a callable coupon bond. We assumed that coupon bond has a maturity of 3 years and is callable only at the second year.
- (b) The market thinks that short term volatility decreases as FED’s plans become clearer. The long term volatilities may increase because mortgage players hedge as FED cuts interest rates.
- (c) A straddle is a “long call and long put” at the same strike price. A swaption long straddle is a long position in the swaptions which are described above. Its cash flow is shown below:
So the traders take a long straddle position on the long dated swaptions and short straddle position on the short dated swaptions.
- (d) If expectations are realized, both positions would be in the money. Trader has assumed a short position on short term volatility and short term volatility is lower. When this position is closed it would be in the money. The trader also has assumed a long position on the long term volatility and the long term volatility is higher so this position is in the money as well. So the positions can simply be unwound.

(e) The investor can make money only if long term volatility increases in the case of CSFB.

Where as in the case of Lehman, even if long term volatility does not increase or even it decreases, earnings from short term volatility position would offset the losses.

Exercise 3

Case Study: Danish Mortgage Bonds

(a) The following is a discussion based upon IFR, Special Report in issue 1239 during the Year 1998.

Danish mortgage bonds have long been domestic investors' referred debt instrument. The combination of a high degree of security and a spread over government bonds means that Danish mortgage bonds form the foundation of the majority of domestic portfolios, professional as well as private investors.

In recent years, international investors have taken increasing interest in the Danish mortgage market and foreign holdings have expanded from DKr40bn (4%) in 1994 to approximately DKr75bn (7%) in the first quarter of 1998.

As a result of more widespread investor interest, most banks have had their mortgage bonds rated by one of the major US credit rating agencies. Moody's Investors Service has assigned ratings of between Aa2 and Aa3 to mortgage bonds issued by Danish mortgage lenders. The fact that no Danish mortgage bank has ever defaulted on its obligations during their 200-year history substantiates the bonds' high degree of safety.

(b) *There are two major explanations for the increased international interest in **Danish mortgage bonds**.*

First, international investors have become more technically oriented; most are no longer deterred from including complex, structured securities in their portfolios. The prospect of European Monetary Union has intensified this development in Europe. Many American investors in particular find that the Danish sector for mortgage bonds is very similar to their domestic mortgage-backed market. Second, the Danish mortgage bond market offers a number of attractive investment openings that may increase the return on a diversified portfolio of debt securities. With approximately Dkr1,013bn in circulation, the market is relatively large, even by international standard. It is very much the market for government bonds, which has attracted foreign investors for many years and has an outstanding volume of Dkr670bn. A number of classes of mortgage bonds can compare with the biggest series in the world.

The table below outlines the major features regarding the most liquid Danish mortgage bonds, although there are transactions with other features:

Coupon 4%-8%

Life 1, 10, 20 or 30 years

Annual repayments 4 and 1

Repayment profile: *Annuity payments but also bullet bonds and serial bonds. Most bonds may be prepaid at par. Termination of a loan generally requires a two-month notice prior to the date of payment.*

Market making For the most liquid bonds. Some 15 brokers are under an obligation to quote amounts of typically Dkr25m to Dkr50m Futures exist in a basket of the 6% bond of 2029 and the 7% of 2029. The Danish market for futures and options is relatively illiquid.

(c) Pricing of Danish mortgage bonds is dominated by the prepayment element. Assessment of future redemption rates is the predominant factor in connection with analysis and pricing. As a result, Danish stockbrokers have a long tradition of analysing and assessing callable bonds and have developed standard pricing methodology. In this context the mortgage banks, via the Copenhagen Stock Exchange, provide a number of data, such as an outline of debtor distribution and weekly prepayments to support the assessment of the prepayment volume.

International investors tend to invest in bonds with the lowest prepayment risk. Most prefer low-coupon bonds, which also reduce the probability of a negative convexity. The expected additional yield compared with government bonds depends among other things on coupons, lifetime and liquidity. The spread to government bonds is relatively high, which means the option adjusted spread (OAS) on a number of benchmark bonds is approximately 70bp compared with an additional yield of only some 20bp to 25bp on the longest German jumbo Pfandbriefe.

(d) Pricing of Danish callable bonds is, generally speaking, based on assumptions about the likelihood that the debtor will call the bonds under different interest rate scenarios. A binomial model describing the future direction of interest rates

combined with distribution assumptions describing debtors' behaviour patterns in the given interest situation is generally applied.

The behaviour relating to calls is normally based on the debtors' profit claims; this is typically assumed to be log-normally distributed. A number of key ratios such as theoretical price, option-adjusted duration, option-adjusted spread and more can be calculated on the basis of the defined binomial tree and the calculated prepayment gains. In addition to advanced option models, CPR models and various equilibrium models are also applied to some extent.

(e) The Danish bond market is characterised by precisely the same trade conventions and settlement procedures for government and mortgage bonds. Consequently, most domestic brokers are able to trade government and mortgage bonds at the same desk. Mortgage bonds in Ecu/euro As of June 2 1998, Nykredit has issued bonds denominated in Ecu that will automatically be redenominated in euros as of January 1 1999. The range of loans includes non-callable bullet loans with maturities of 1 to 11 years with coupons of 4% and callable annuity loans with maturities of 10, 20 and 30 years carrying coupons of 4% for bonds due between 2008 and 2018, 5% until 2028 and 6% for even longer securities.

Exercise 4

(Interest Rate Cap Pricing)

(For detailed calculation see also Excel file 'Exercise 17.4 Solution Excel Calculation' on book webpage.)

Calculation

Price of the interest rate cap is given by $\sum_{i=1}^n B(t_0, t_{i+1}) * \text{Max}((L(t_0, t_i) - C), 0) * N$

$$\text{where, } B(t_0, t_i) = \frac{100}{\prod_{j=0}^{i-1} (1 + \delta F(t_0, t_j))}$$

Hence the price = \$ **2.650**

Exercise 5

(Interest Rate Floor Pricing)

(For detailed calculation see also Excel file ‘Exercise 17.4 Solution Excel Calculation’ on book webpage.)

Calculation

Price of the interest rate floor is given by $\sum_{i=1}^n B(t_0, t_{i+1}) * \text{Max}((Fl - L(t_0, t_i)), 0) * N$

$$\text{where, } B(t_0, t_i) = \frac{100}{\prod_{j=0}^{i-1} (1 + \delta F(t_0, t_j))}$$

Hence the price = \$ **3.506**